Task 2.3

How much of PM_{10} is composed of $PM_{2.5}$ and how does this relationship change by measurement site, time of day, and season? What meteorological and source emission characteristics are associated with differences in the ratio? How accurately can $PM_{2.5}$ concentrations be deduced from PM_{10} measurements? Where and when is the coarse crustal component in PM10?

1. Introduction

The PM concentrations in California vary seasonally depending on the nature of predominant emission sources and meteorological factors. The seasonality is most pronounced in the San Joaquin Valley, where both PM_{10} and $PM_{2.5}$ levels are low during the spring and summer, with PM_{10} reaching peak values in the fall and early winter and $PM_{2.5}$ reaching highest values in the winter. Other air basins in California, like the San Francisco Bay Area, Sacramento Valley, San Diego, North Coast, and Mojave Desert, exhibit similar but less pronounced seasonality.

The $PM_{2.5}/PM_{10}$ ratio depends on meteorology and emission sources. Data obtained from the Sacramento dichotomous sampler show that in 1999 and 2000 the $PM_{2.5}$ portion of PM_{10} ranged from 13% to 86%. The two-year average $PM_{2.5}$ portion of PM_{10} from November through February was 68% dropping to 43% from March through October.

2. Objectives

The primary objective of Task 2.3 is to analyze variations in $PM_{2.5}$/ PM_{10} ratios using the long-term database and the CRPAQS database.

The specific objectives of this task are:

- Examine spatial, temporal, and diurnal variations in $PM_{2.5}/PM_{10}$ ratios.
- Identify meteorological and source emissions characteristics associated with differences in ratios.
- Compare the following ratios:
    - Dichot $PM_{10}/PM_{2.5}$.
    - SSI PM_{10}/FRM $PM_{2.5}$.
    - DRI SFS $PM_{10}/PM_{2.5}$.
    - BAM $PM_{10}/PM_{2.5}$.
- Determine if site and season specific $PM_{2.5}/PM_{10}$ ratios can provide accurate estimates of one parameter in the absence of another.
- Examine variations in the crustal component of PM_{10} and the relationship between the crustal component and $PM_{2.5}/PM_{10}$ ratios.

3. Technical Approach

A. Data Included in the Analysis

The following ambient data from the routine network and the CRPAQS will be used in the analysis:

- Dichot PM_{10} and $PM_{2.5}$.
- SSI PM_{10}
- FRM $PM_{2.5}$.
- DRI SFS PM_{10} and $PM_{2.5}$.
- BAM PM_{10} and $PM_{2.5}$.

In addition to ambient air quality data the following data must be available to accomplish this task:

- CMB source apportionment site-specific results.
- Gridded emission inventory estimates for sites that did not collect chemical speciation data.
- Meteorological data.

B. Types of Analysis

The routine PM_{10} and $PM_{2.5}$ mass data for 1990-2001 as well as CRPAQS data will be used to compute the following ratios:

- Dichot $PM_{10}/PM_{2.5}$.
- SSI PM_{10}/FRM $PM_{2.5}$
- DRI SFS $PM_{10}/PM_{2.5}$.
- BAM $PM_{10}/PM_{2.5}$.

The ratios will be temporally averaged for each site and spatially averaged for each sampling interval. The initial analyses, listed below, will improve the understanding of spatial and temporal variability in ratios.

- Summary statistics and time series of ratios by site.
- Temporally averaged ratios for each station.
- Spatially averaged ratios for each time period.

The association between high concentrations of both $PM_{2.5}$ and PM_{10} will also be examined. We will determine when and where the high $PM_{2.5}$ concentrations coincide with high PM_{10} concentrations.

To identify meteorological and source emission characteristics associated with differences in ratio the calculated ratios will be analyzed using three different techniques described below:

1. Define groups with similar ratios.
   Group together days with similar ratios. Within each group analyze meteorological conditions and source contribution estimates. Compare the meteorological conditions and source contribution estimates between groups.
2. Define groups with similar meteorology.
   Group together days with similar meteorology using the cluster analysis technique. Within each group analyze variability in ratios and source contribution estimates. Compare the ratios and source contribution estimates between groups.
3. Create clusters that cause the greatest difference in ratios using classification tree analysis.

Several monitoring sites have multiple instruments that will allow calculating multiple ratios (Dichot $PM_{2.5}/PM_{10}$, FRM $PM_{2.5}$/SSI PM_{10}, DRI SFS $PM_{2.5}/PM_{10}$, and/or BAM $PM_{2.5}/PM_{10}$). Using regression and correlation analysis we will compare the ratios for each site. We will determine if the ratios derived using the same type of monitoring instrument (Dichot $PM_{2.5}/PM_{10}$, DRI SFS $PM_{2.5}/PM_{10}$ and BAM $PM_{2.5}/PM_{10}$) are better correlated than the ratios derived using different types of instruments (SSI PM_{10}/FRM $PM_{2.5}$).

Particle sources are either primary-directly emitted, or secondary-formed via atmospheric reaction. Coarse particles are dominated by crustal elements (soil and dust) and $PM_{2.5}$ by inorganic particles and carbonaceous materials. High $PM_{2.5}$ mass concentration episodes are the result of meteorology conductive to secondary particle formation (i.e., stable air masses, low wind speeds, cool temperatures). High concentrations of coarse particles result from the suspended dust and may be associated with windy conditions (windblown dust) or stagnant conditions (mechanically suspended dust due to motor vehicles and agricultural activites). The CMB data will be used to evaluate crustal fraction of PM_{10} and $PM_{2.5}$ mass. Temporal and spatial variations in crustal fraction will be examined for patterns and magnitude of variations.

C. Technical Support

The ARB Statistical Support Section staff will provide technical support in performing statistical analyses, including cluster analysis and classification tree analysis. The ARB Modeling Section staff will provide technical support in processing and evaluating emission estimates.

4. Schedule and Deliverables

The schedule for completion of milestones is shown in Table 1.

Table 1. Schedule

Completion Date	Task
October 2002	Calculate ratios based on routine network data for 1990-2001.
November 2002	Prepare meteorological data.
December 2002	Calculate ratios based on CRPAQS data. Update the ratios calculated based on routine network data, if necessary.
	Group data with similar ratios.
	Compare ratios between different sampling methods using regression and correlation analyses.
January 2003	Define groups with similar meteorology using cluster analysis technique.
February 2003	Analyze variability in ratios within each group with similar meteorology.
	Compare the ratios between the groups with similar meteorology.
March 2003	Process and analyze CMB source apportionment results (contingent upon timely receipt of CMB modeling results).
	Process and analyze emission estimates (contingent upon timely receipt of modeling results from ARB/Modeling Section).
June 2003	Perform classification tree analysis.
July 2003	Analyze variability in meteorology and source contribution estimates within each group with similar ratios.
July 2003	Analyze variability in ratios and source contribution estimates within each group with similar meteorology.
August 2003	Compare groups with similar ratios.
August 2003	Compare groups with similar meteorology.
October 2003	Draft report.
November 2003	Final report.